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Rotational evolution of exoplanets under the action of gravitational and magnetic perturbations

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Abstract

We investigate the evolution of the rotational axes of exoplanets under the action of gravitational and magnetic perturbations. The planet is assumed to be dynamically symmetrical and to be magnetised along its dynamical-symmetry axis. By qualitative methods of the bifurcation theory of multiparametric PDEs, we have derived a gallery of 69 phase portraits. The portraits illustrate evolutionary trajectories of the angular momentum L → of a planet for a variety of the initial conditions, for different values of the ratio between parameters describing gravitational and magnetic perturbations, and for different rates of the orbital evolution. We provide examples of the phase portraits, that reveal the differences in topology and the evolutionary track of L → in the vicinity of an equilibrium state. We determine the bifurcation properties, i.e., the way of reorganisation of phase trajectories in the vicinities of equilibria; and we point out the combinations of parameters' values that permit ip-overs from a prograde to a retrograde spin mode. © 2008 Springer Science+Business Media B.V.

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Keywords

Bifurcation theory, Exoplanets, Gravitational and magnetic perturbations, Qualitative analysis, Rotational evolution